Signal Tagging and Filtering Based Upon Trigonometric Analysis of Previous Signal Strikes Against Rotating Spherical Metamaterial Antenna for Jamming Prevention

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Introduction

While there are a great many approaches to jamming prevention, some of which have already been promulgated by this author, these approaches are often more effective when combined with one another. It is prudent to continue to develop a reservoir of novel concepts even when it seems that a panacea-type solution has already been found. Oftentimes, these secondary concepts turn out to be the better of multiple possible solutions or to be more practical than primary solutions.

Abstract

The most commonly jammed type of platform is the remote-controlled (drone) aircraft. While drones offer as advantages low financial and human cost of operation, their primary drawback is susceptibility to hijacking. Robust countermeasures against this, particularly if they can be kept secret, can overcome this problem.

One solution not yet tried is to filter incoming electromagnetic signals according to their angular momentum and for remote platforms to accept signals only emanating from angular directions consistent with trusted signal sources. Generally, these control signals emanate from satellites with known relative positions. As long as the platform knows where it is (and it should with GPS) and as long as it knows its bearing (and it should with a compass) it should know from which direction to listen for signals. Unfortunately, an abrupt shift in the position of the aircraft or a surge in jamming can render a magnetic compass unreliable, making it difficult to compute the true bearing of the aircraft and therefore could frustrate such an approach to assured communications.

In order to overcome this challenge (including the prospect of a GPS-denied environment,) a gyroscopic approach similar to that used in early inertial navigation systems can be used in order to maintain a consistent relationship between particular regions of a Rotating Spherical Receiver Module (RSRM) composed of metamaterials and a guidance satellite.

A metamaterial receiver etched upon a "floating ball" sitting in a fluid and spinning at a moderate velocity would act as a sort of gimbal which would remain steady regardless of any change in the orientation of a drone aircraft. Each microscopic sub-region of metamaterial would "listen for" signals only from a direction corresponding with the exact zenith relative to a line drawn from the

center of the floating ball through its surface. In other words, only a signal striking a sub-region perfectly squarely will be registered by the signal processor. As the entire surface of the sphere would be coated with the metamaterial used as an antenna, signals from every possible direction would be observed and logged, but meta tagging would allow the signal processor to choose to ignore any information coming from directions which are not associated with trusted sources. Signals coming from varying points of origin would be tagged according to the physical zone of the sphere upon which they strike.

A control system within the drone would maintain constant awareness of the relative physical position of each physical part of the receiver sphere and would maintain a pre-programmed awareness of the anticipated position of control satellites according to time and GPS/Inertial NAV-indicated position. Rather than trying to guess at bearing using vulnerable tools like magnetic compass or inaccurate methods such as inertial NAV, the Rotating Spherical Receiver Module (RSRM) would estimate its position relative to the authentic satellite by continually tracking the point of strike of authentic signals on the sphere and correcting for any errors in inertia in real-time using continued pings. This system would guard against jamming, against errors in the inertial accuracy of the gimbalized RSRM system and would continue to maintain the ability to receive data in the presence of vibrations in the airframe caused by turbulence.

Crucial to the proper functionality of the RSRM concept is the use of a metamaterial which only permits electromagnetism to proceed through the layers which approaches the surface at exact zenith so as to prevent jamming signals from interfering with authentic signals by burrowing between vertical channels. Once activated, the zones along the sphere which will be treated as "credible" will be based upon a simple projection of previously received authentic packets. Variables such as rotational direction and speed of the RSRM and time between packets would be known, thereby making it a relatively straightforward matter to extrapolate which regions of the sphere should be expected to interact with authentic signal next. Not only does this ensure the ability to send command and control signals to a drone in a contested environment, it ensures that information concerning GPS-indicated position is able to make it to the aircraft despite jamming. Although "GPS 3.0" satellites incorporate jamming-resistant angular-momentum filtering including helicity measurement using multiple, layered measurement plates, ground-level jamming of the return signals from these satellites may continue to pose a challenge absent the utilization of a system such as RSRM.

In this way, it is not necessary to employ highly collimated beams a la the satellite-to-satellite LASERCOM drift correction system in which a prism is used to measure angle-of-strike of a beam so as to correct the angle of projection of communications beams before a receiving satellite drifts too far out of the beam and results in a broken link. Whereas in that application, data security is predicated upon maximal collimation, in this application, the prevention of spoofing is all that is required. As such, an antenna must be able to discriminate

between signals from varying angular directions and the system must be able to, as a unified whole, make a determination as to which directions to treat as trustworthy. The downlink from the satellite need not be collimated in order for this scheme to be highly effective.

Conclusion

The RSRM system combines the strengths of unidirectionality with the strengths of a gimbal system, creating a novel mechanism relying upon a hybrid of old and new technologies which enable the jam-proofing of drone platforms using relatively simple trigonometric functions. RSRM would ensure the ability to maintain control over drone platforms as well as ensuring the function of GPS systems generally in GPS-denied environments, making its development both mission and time-critical.